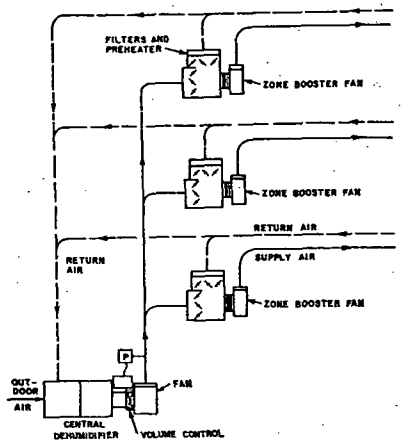

Fig. 11 .... Booster Fan System with Single Central Dehumidified Air System

mum ease of maintenance, it is desirable to maintain the spacing shown as a minimum.

Special Arrangements

Zoning. Fig. 10 shows one method of zoning central station units with a separate fan, dehumidifier face damper, and bypass reheat coil and damper for each zone. Zoning can also be accomplished by a single fan with large duct reheat coils in separate zone ducts on the discharge side of a single fan. A third method is to have a blow-through arrangement as shown by Fig. 3 with a separate set of mixing dampers for each zone duct.

Booster Fans. For large buildings with a number of zones, it might be desirable to have a single central dehumidified air system to take advantage of cooling load diversity, and remote zone booster fans adjacent to the area served. This type of arrangement often results in smaller distribution duct sizes and fan horsepower savings. Fig. 11 shows a schematic representation of a booster fan system.

Since the demand on dehumidified air is variable, it is necessary to control at constant discharge static pressure which is generally done by a static pressure regulator controlling variable vane inlet dampers on the fan.

Run-Around Coil. When 100 percent outdoor air is used in a central station air system, a considerable amount of heat can be recovered by means of a *run-around* coil arrangement as shown in Fig. 12. Before the air is exhausted it is passed through a recovery coil. A water circulating system, transfers the recovered heat to a pre-conditioning coil in the supply fan system. Fig. 13 shows the percent of heat recovery from exhaust air that can be obtained assuming an indoor design temperature of 75 F.

An example will serve to illustrate the use of Fig. 13. Assume a hospital air conditioning system requiring 100 percent outdoor air has a 0 F design outdoor temperature, 75 F indoor air temperature and an air supply quantity of 10,000 cfm. The outdoor air heating load at design conditions would be 810,000 Btu per hr. With a *run-around* coil system as shown by Fig. 12, using 6 row coils, selected on approximately 500 fpm face velocity, it can be determined by Fig. 13 that approximately 47 percent of outdoor air heating load can be recovered from the exhaust air assuming the coils have a heat transfer rate as indicated on Fig. 13. The air leaving the recovery coil can be determined as $\Delta T = 0.47 \times (75-0) = 35$ F. If 8-row coils were used, approximately 54 percent outdoor air heating load could be recovered and the leaving air would be approximately 39 F. It would be a matter of economics to determine if the initial cost of the coils, and the number of rows of tubes, can be justified on the basis of reducing the required capacity of the heating system, and the fuel savings resulting from the recovery of heat from the exhaust air.

If an anti-freeze solution is not used in the piping circuit, it is necessary to have a pre-conditioning coil circuited to have a minimum of 2½ fpm water velocity through the tubes to prevent freezing. It is important that the water be circuited counterflow to the air to obtain the recovery indicated by Fig. 13.

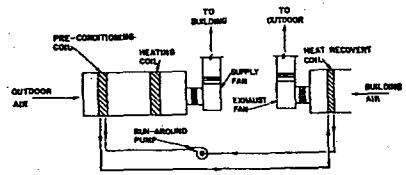

Fig. 12 .... Arrangement of Run-Around Coil System

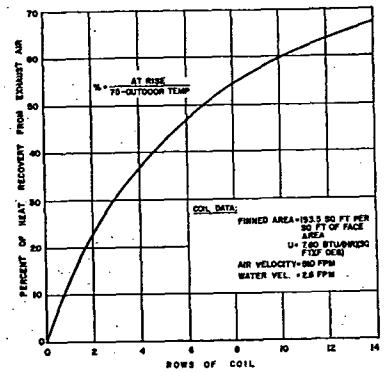

Fig. 13 .... Heat Recovery from Exhaust Air in a Run-Around Coil System

DUAL-DUCT, INDUCTION UNIT, AND FAN-COIL CONDITIONER SYSTEMS

DUAL-DUCT SYSTEMS: Basic Systems, Design, Sizing of Cold and Warm Ducts, Types of Mixing Units, Control, Refrigeration Plant Capacity, System Layouts, Installed Costs; INDUCTION UNIT SYSTEMS: Application for Multi-Room Buildings, All-Air System, Unit Description and Selection Criteria, System Description, Design Procedure; Air-Water System, Unit Description and Selection Criteria, System Description, Design Procedure; Three-Pipe System, Unit Description and Selection, Primary System, Secondary Water Piping; FAN-COIL CONDITIONER SYSTEMS: Adaptation to Building Types, System Variations, Types, Application, Load Calculation, Central Station Equipment, Ventilation-Air Systems, Water Systems, Wiring and Control, Installation and Operation

THIS chapter discusses three types of multi-zone air-conditioning systems which also include central station equipment, as described in Chapter 1, but differ in the method of distributing air to the various zones, or in the terminal units used in the various rooms.

These systems are: (1) dual-duct, (2) induction unit, and (3) fan-coil conditioner. Several variations of each type are discussed.

PART I—DUAL-DUCT SYSTEMS

The dual-duct system of air conditioning found its application in structures requiring a multiplicity of zones, such as office buildings, hotels, schools, apartment houses, hospitals, and ships. The requirements of the different zones are met by mixing cold and warm air in a device responsive to a room thermostat. The air flowing in the cold and warm air ducts is conditioned centrally and distributed throughout the building by a system of two parallel ducts. The return air is usually handled in a conventional manner.

The principal advantages of dual-duct air-conditioning systems are:

1. All conditioning equipment is centrally located, thereby simplifying maintenance and operation.
2. Cooling and heating can be obtained simultaneously without central zoning or seasonal changeover.
3. When 100 percent air systems are used there is complete absence of water, steam, and drain piping; electrical equipment; wiring; and filters in conditioned spaces.
4. The system can utilize outdoor air to the fullest extent for cooling purposes during intermediate seasons.
5. Flexibility is obtained to meet specific design or cost objectives in any particular installation.
6. The system can be used in combination with direct radiation or with other conditioning methods to avoid the necessity of placing mechanical equipment at the perimeter of the building, and thereby save valuable floor area. This feature is especially valuable in existing buildings when removal of an existing heating system is unnecessary or not otherwise justified.

The main considerations in the design of a dual-duct system are as follows:

1. In order to make the system mechanically stable, some provisions must be incorporated in the system for control of volumetric delivery.
2. Due to space limitations in the majority of installations, velocities and pressures are higher in the duct system than those required in conventional installations.
3. The arrangement of two parallel ducts with cross-overs to terminal points will require special attention, study, and technique on the part of designer and installer.
4. Accessibility to terminal mixing devices will demand close cooperation between architectural, mechanical, and structural designers.

BASIC SYSTEMS

The dual-duct system conditions all the air in a central apparatus and distributes it to the conditioned spaces through two parallel mains or ducts. One duct carries cold air, and the other warm air, thus providing air sources for both heating and cooling at all times. In each conditioned space or zone, a mixing valve responsive to a room thermostat mixes the warm and cold air in proper proportions to satisfy the prevailing heat load of the space.

Basic dual-duct cycles are shown in Figs. 1, 2, 3, and 4. Modification of these arrangements may be required due to design conditions. Thermodynamically, all dual-duct cycles are equivalent to certain conventional single-duct systems having face and bypass dampers at the cooling coils. Functionally, the cold and warm duct dampers in dual-duct mixing units are similar to the face and bypass dampers in a conventional single-duct system, except that the dual-duct system possesses the necessary flexibility for automatic zoning of each area independently.

Consideration must be given to maintenance of conditions in lightly loaded zones and no-load zones. The ability of any type of system to maintain conditions in no-load zones is a criterion of adequacy of design for a particular installation. Experience has shown that when dual-duct systems are designed to satisfy the conditions of no-load zones, such systems in actual operation will maintain acceptable room conditions at all times.

Outdoor-air dampers at the central apparatus are usually split into two sections, one for minimum, the other for maximum outdoor air volume. The maximum outdoor-air damper is interlocked with both return and relief dampers and opens whenever outdoor air is favorable for cooling purposes. In climates where outdoor air is not suitable for cooling, only

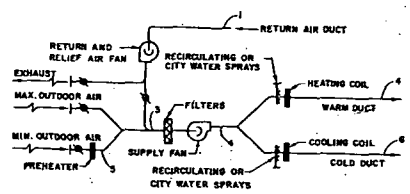

Fig. 1 .... Single-fan Dual-duct Cycle with Blow-through Dehumidifier